$50,550. The lowest 10 percent earned less than $22,800 and the highest 10 percent earned over $78,920. Most landscape architects worked in the landscape and horticultural services industry, where their median annual earnings were $33,600 in 1997.

In 1999, the average annual salary for all landscape architects in the Federal Government in nonsupervisory, supervisory, and managerial positions was about $57,500.

Because many landscape architects work for small firms or are self-employed, benefits tend to be less generous than those provided to workers in large organizations.

Related Occupations

Landscape architects use their knowledge of design, construction, land-use planning, and environmental issues to develop a landscape project. Others whose work requires similar skills are architects, surveyors, civil engineers, soil conservationists, and urban and regional planners. Landscape architects also know how to grow and use plants in the landscape. Botanists, who study plants in general, and horticulturists, who study ornamental plants as well as fruit, vegetable, greenhouse, and nursery crops, do similar work.

Sources of Additional Information

Additional information, including a list of colleges and universities offering accredited programs in landscape architecture, is available from:

☛ American Society of Landscape Architects, Career Information, 636 Eye Street, NW., Washington, DC 20001. Internet: **http://www.asla.org**

General information on registration or licensing requirements is available from:

☛ Council of Landscape Architectural Registration Boards, 12700 Fair Lakes Circle, Suite 110, Fairfax, VA 22033.

Surveyors, Cartographers, Photogrammetrists, and Surveying Technicians

(O*NET 22311A, 22311B, 22521A, 22521B, and 25103B)

Significant Points

- Over 8 out of 10 are employed in engineering services and government.
- Computer skills enhance employment opportunities.

Nature of the Work

Measuring and mapping the earth's surface is the responsibility of several different types of workers. Traditional *land surveyors* establish official land, air space, and water boundaries. They write descriptions of land for deeds, leases, and other legal documents; define air space for airports; and measure construction and mineral sites. Other surveyors provide data relevant to the shape, contour, location, elevation, or dimension of land or land features. *Surveying technicians* assist land surveyors by operating survey instruments and collecting information. *Cartographers* compile geographic, political, and cultural information and prepare maps of large areas.

Land surveyors manage survey parties that measure distances, directions, and angles between points and elevations of points, lines, and contours on the earth's surface. They plan the fieldwork, select known survey reference points, and determine the precise location of important features in the survey area. Surveyors research legal records and look for evidence of previous boundaries. They record the results of the survey, verify the accuracy of data, and prepare plots, maps, and reports. Surveyors who establish boundaries must be licensed by the State in which they work.

A survey party gathers the information needed by the land surveyor. A typical survey party consists of a party chief and several surveying technicians and helpers. The party chief, who may be either a land surveyor or a senior surveying technician, leads day-to-day work activities. Surveying technicians assist the party chief by adjusting and operating surveying instruments, such as the theodolite (used to measure horizontal and vertical angles) and electronic distance-measuring equipment. Surveying technicians or assistants position and hold the vertical rods, or targets, that the theodolite operator sights on to measure angles, distances, or elevations. They may also hold measuring tapes, if electronic distance-measuring equipment is not used. Surveying technicians compile notes, make sketches, and enter the data obtained from these instruments into computers. Survey parties may include laborers or helpers who perform less skilled duties, such as clearing brush from sight lines, driving stakes, or carrying equipment.

New technology is changing the nature of the work of surveyors and surveying technicians. For larger projects, surveyors are increasingly using the Global Positioning System (GPS), a satellite system that precisely locates points on the earth by using radio signals transmitted via satellites. To use this system, a surveyor places a satellite signal receiver—a small instrument mounted on a tripod—on a desired point. The receiver simultaneously collects information from several satellites to locate a precise position. The receiver can also be placed in a vehicle for tracing out road systems. Since receivers now come in different sizes and shapes and the cost of the receivers has fallen, much more surveying work is being done using GPS. Surveyors then must interpret and check the results produced by the new technology.

Cartographers measure, map, and chart the earth's surface, which involves everything from geographical research and data compilation to actual map production. They collect, analyze, and interpret both spatial data—such as latitude, longitude, elevation, and distance—and nonspatial data—such as population density, land use patterns, annual precipitation levels, and demographic characteristics. Cartographers prepare maps in either digital or graphic form, using information provided by geodetic surveys, aerial photographs, and satellite data. *Photogrammetrists* prepare detailed maps and drawings from aerial photographs, usually of areas that are inaccessible or difficult to survey by other methods. *Map editors* develop and verify map contents from aerial photographs and other reference sources.

Some surveyors perform specialized functions that are closer to those of a cartographer than to those of a traditional surveyor. For example, *geodetic surveyors* use high-accuracy techniques, including satellite observations, to measure large areas of the earth's surface. *Geophysical prospecting surveyors* mark sites for subsurface exploration, usually petroleum related. *Marine surveyors* survey harbors, rivers, and other bodies of water to determine shorelines, topography of the bottom, water depth, and other features.

The work of surveyors and cartographers is changing because of advancements in technology. These advancements include not only the GPS, but also new earth resources data satellites, improved aerial photography, and geographic information systems (GIS)—which are computerized data banks of spatial data. From the older specialties of photogrammetrist and cartographer, a new type of mapping scientist is emerging. The *geographic information specialist* combines the functions of mapping science and surveying into a broader field concerned with the collection and analysis of geographic information.

Working Conditions

Surveyors usually work an 8-hour day, 5 days a week, and may spend a lot of time outdoors. Sometimes they work longer hours during the summer, when weather and light conditions are most suitable for fieldwork.

A surveyor sets up equipment to measure and record recent changes to the topography.

Land surveyors and technicians engage in active, and sometimes strenuous, work. They often stand for long periods, walk considerable distances, and climb hills with heavy packs of instruments and other equipment. They can also be exposed to all types of weather. Traveling is often part of the job; they may commute long distances, stay overnight, or temporarily relocate near a survey site.

While surveyors can spend considerable time inside planning surveys, analyzing data, and preparing reports and maps, cartographers spend virtually all their time in offices and seldom visit the sites they are mapping.

Employment

Surveyors, cartographers, photogrammetrists, and surveying technicians held about 110,000 jobs in 1998. Engineering and architectural services firms employed about 64 percent of these workers. Federal, State, and local governmental agencies employed an additional 17 percent. Major Federal Governmental employers are the U.S. Geological Survey, the Bureau of Land Management, the Army Corps of Engineers, the Forest Service, the National Oceanic and Atmospheric Administration, and the National Imagery and Mapping Agency (NIMA). Most surveyors in State and local government work for highway departments and urban planning and redevelopment agencies. Construction firms, mining and oil and gas extraction companies, and public utilities also employ surveyors, cartographers, photogrammetrists, and surveying technicians. About 6,800 were self-employed in 1998.

Training, Other Qualifications, and Advancement

Most people prepare for a career as a licensed surveyor by combining postsecondary school courses in surveying with extensive on-the-job training. However, as technology advances, a 4-year degree is becoming more of a prerequisite. About 25 universities now offer 4-year programs leading to a B.S. degree in surveying. Junior and community colleges, technical institutes, and vocational schools offer 1-, 2-, and 3-year programs in both surveying and surveying technology.

All 50 States license land surveyors. For licensure, most State licensing boards require that individuals pass two written examinations, one prepared by the State and one given by the National Council of Examiners for Engineering and Surveying. In addition, they must meet varying standards of formal education and work experience in the field. In the past, many individuals started as members of survey crews and worked their way up to become licensed surveyors with little formal training in surveying. However, because of advancing technology and an increase in licensing standards, formal education requirements are increasing. At present, most States require some formal post-high school education coursework and 10 to 12 years of surveying experience to gain licensure. However, requirements vary among States. Generally, the quickest route to licensure is a combination of 4 years of college, 2 to 4 years of experience (a few States do not require any), and passing the licensing examinations. An increasing number of States require a bachelor's degree in surveying or in a closely related field, such as civil engineering or forestry (with courses in surveying), regardless of the number of years of experience.

High school students interested in surveying should take courses in algebra, geometry, trigonometry, drafting, mechanical drawing, and computer science. High school graduates with no formal training in surveying usually start as an apprentice. Beginners with postsecondary school training in surveying can usually start as technicians or assistants. With on-the-job experience and formal training in surveying—either in an institutional program or from a correspondence school—workers may advance to senior survey technician, then to party chief, and in some cases, to licensed surveyor (depending on State licensing requirements).

The American Congress on Surveying and Mapping has a voluntary certification program for surveying technicians. Technicians are certified at four levels requiring progressive amounts of experience, in addition to passing written examinations. Although not required for State licensure, many employers require certification for promotion to positions with greater responsibilities.

Surveyors should have the ability to visualize objects, distances, sizes, and abstract forms. They must work with precision and accuracy because mistakes can be costly. Members of a survey party must be in good physical condition, because they work outdoors and often carry equipment over difficult terrain. They need good eyesight, coordination, and hearing to communicate verbally and manually (using hand signals). Surveying is a cooperative process, so good interpersonal skills and the ability to work as part of a team are important. Leadership qualities are important for party chief and other supervisory positions.

Cartographers and photogrammetrists usually have a bachelor's degree in a field such as engineering, forestry, geography, or a physical science. Although it is possible to enter these positions through previous experience as a photogrammetric or cartographic technician, most cartographic and photogrammetric technicians now have had some specialized postsecondary school training. With the development of Geographic Information Systems, cartographers and photogrammetrists need additional education and stronger technical skills—including more experience with computers—than in the past.

The American Society for Photogrammetry and Remote Sensing has a voluntary certification program for photogrammetrists. To qualify for this professional distinction, individuals must meet work experience standards and pass an oral or written examination.

Job Outlook

Overall employment of surveyors, cartographers, photogrammetrists, and surveying technicians is expected to grow about as fast as the average through the year 2008. The widespread availability and use of advanced technologies, such as the Global Positioning System, Geographic Information Systems, and remote sensing, are increasing both the accuracy and productivity of survey and mapping work. Job openings, however, will continue to result from the need to replace workers who transfer to other occupations or leave the labor force altogether.

Prospects will be best for surveying technicians, whose growth is expected to be slightly faster than the average for all occupations through 2008. The short training period needed to learn to operate the equipment, the current lack of any formal testing or licensing, and the relatively lower wages all make for a healthy demand for these technicians, as well as for a readily available supply.

As technologies become more complex, opportunities will be best for surveyors, cartographers, and photogrammetrists who have at least a bachelor's degree and strong technical skills. Increasing demand for geographic data, as opposed to traditional surveying services, will mean better opportunities for cartographers and photogrammetrists involved in the development and use of geographic and land information systems. New technologies, such as GPS and GIS may also enhance employment opportunities for surveyors and surveying technicians who have the educational background enabling them to use these systems, but upgraded licensing requirements will continue to limit opportunities for those with less education.

Even as demand increases in nontraditional areas such as urban planning and natural resource exploration and mapping, opportunities for surveyors, cartographers, and photogrammetrists should remain concentrated in engineering, architectural, and surveying services firms. Growth in construction through 2008 should require surveyors to lay out streets, shopping centers, housing developments, factories, office buildings, and recreation areas. However, employment may fluctuate from year to year along with construction activity.

Earnings

Median annual earnings of surveyors, cartographers, and photogrammetrists were $37,640 in 1998. The middle 50 percent earned between $27,580 and $50,380. The lowest 10 percent earned less than $21,510 and the highest 10 percent earned more than $76,880.

Median hourly earnings of surveying technicians were $11.20 in 1997 for those employed in engineering and architectural services, while those employed by local governments received median hourly earnings of $13.50. The middle 50 percent of all surveying technicians earned between $9.86 and $16.54 in 1998. The lowest 10 percent earned less than $7.61 and the highest 10 percent earned more than $21.14.

In 1999, land surveyors in nonsupervisory, supervisory, and managerial positions in the Federal Government earned an average salary of $52,400; cartographers earned an average salary of $56,300. The average Federal salary for geodetic technicians is $48,800; for surveying technicians, about $31,300; and for cartographic technicians, about $37,200.

Related Occupations

Surveying is related to the work of civil engineers and architects, since an accurate survey is the first step in land development and construction projects. Cartography and geodetic surveying are related to the work of geologists and geophysicists, who study the earth's internal composition, surface, and atmosphere. Cartography is also related to the work of geographers and urban planners, who study and decide how the earth's surface is used.

Sources of Additional Information

Information about career opportunities, licensure requirements, and the surveying technician certification program is available from:

☛ American Congress on Surveying and Mapping, 5410 Grosvenor Lane, Suite 100, Bethesda, MD 20814-2122.

General information on careers in photogrammetry is available from:

☛ ASPRS: The Imaging and Geospacial Information Society, 5410 Grosvenor Lane, Suite 210, Bethesda, MD 20814.

General information on careers in cartography is available from:

☛ North American Cartographic Information Society, P.O. Box 399, Milwaukee, WI 53201-0399.

Computer, Mathematical, and Operations Research Occupations

Actuaries

(O*NET 25313)

Significant Points

- A strong background in mathematics is essential for an actuary.
- About 2 out of 3 actuaries are employed in the insurance industry.
- Employment opportunities will be good despite the limited number of openings in this small occupation as stringent qualifying requirements induced by the examination system limit the number of new entrants.

Nature of the Work

Actuaries are essential employees because they determine future risk, make price decisions, and formulate investment strategies. Some actuaries also design insurance, financial, and pension plans and ensure that these plans are maintained on a sound financial basis. Most actuaries specialize in life and health or property and casualty insurance; others work primarily in finance or employee benefits. Some use a broad knowledge of business and mathematics in investment, risk classification, or pension planning.

Regardless of specialty, actuaries assemble and analyze data to estimate probabilities of an event taking place, such as death, sickness, injury, disability, or property loss. They also address financial questions, including the level of pension contributions required to produce a certain retirement income level or the projected future return on investments. Moreover, actuaries may help determine company policy and sometimes explain complex technical matters to company executives, government officials, shareholders, policyholders, or the public in general. They may testify before public agencies on proposed legislation affecting their businesses or explain changes in contract provisions to customers. They also may help companies develop plans to enter new lines of business.

Most actuaries are employed in the insurance industry, in which they estimate the amount a company will pay in claims. For example, property/casualty actuaries calculate the expected amount of claims resulting from automobile accidents, which varies depending on the insured person's age, sex, driving history, type of car, and other factors. Actuaries ensure that the price, or premium,